POST AND TELECOMMUICATIONS INSTITUTE OF TECHNOLOGY

Embedded systems

Faculty: **Computer science – IT1**

COMPONENT POINTS

- Attendance: 10%
- Exercices: 10%
- Project: 20%
- Final exam: 60%

CONTENT

- Chapter 1: Introduction
- Chapter 2: Hardware components of embedded systems Chapter
- Chapter 3: Software components of embedded systems Chapter
- Chapter 4: Embedded system design and installation

Chapter 1: INTRODUCTION

DEFINITIONS OF EMBEDDED SYSTEMS

1. Function: organize or carry out one or more tasks based on a set of rules, plans, programs.

2. .Combine and arrange functional units to perform tasks together.

3. For example: clock, washing machine...

DEFINITIONS OF EMBEDDED SYSTEMS

1. A system where hardware is integrated with software to execute a certain application, or part of an application in a larger system.

2. A system that has software with certain functions embedded in the computer.

3. Is a hardware system for a certain product or application. It can be a stand-alone system or part of a larger system. Software is embedded in ROM or flash.

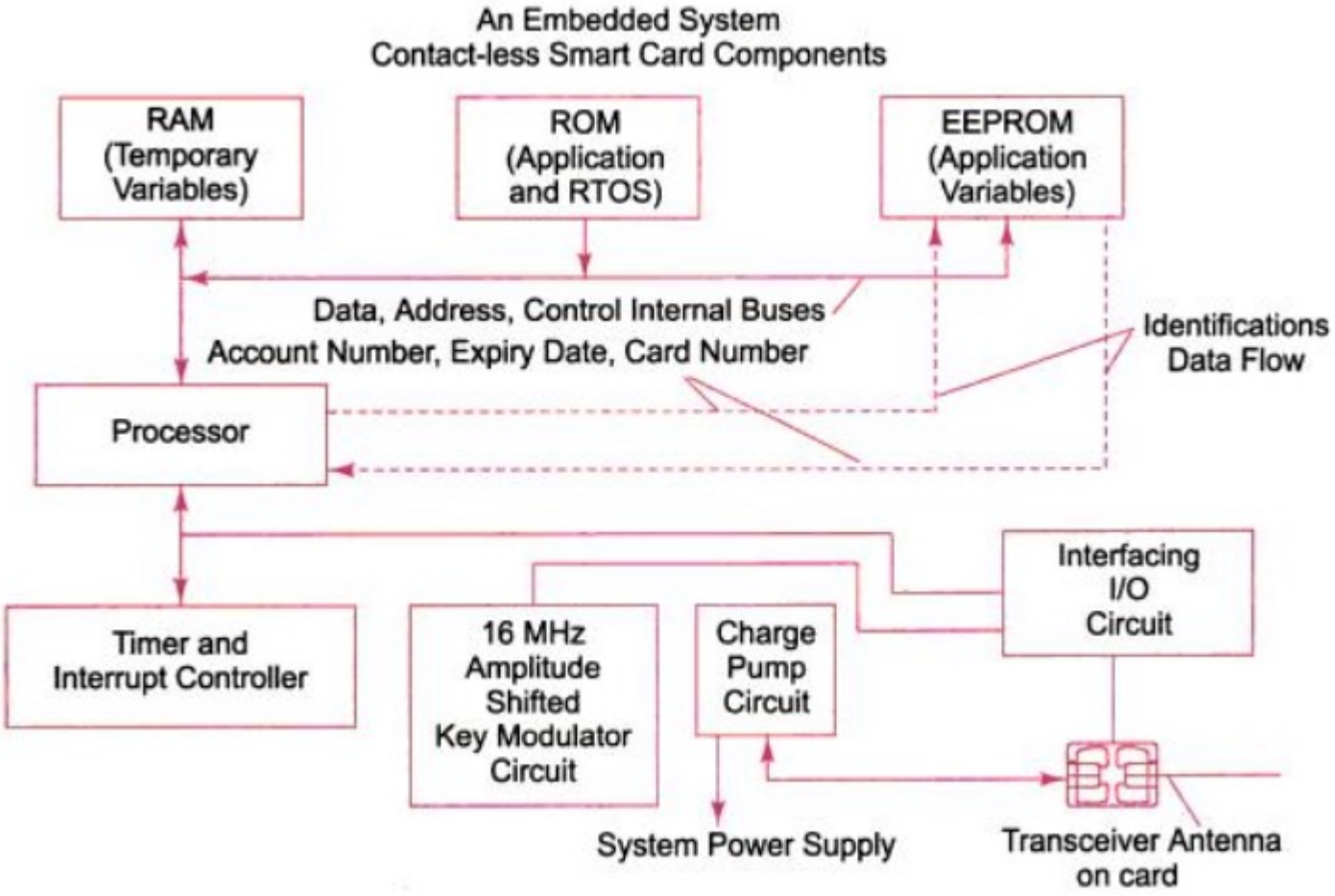
MAIN PARTS

1. Hardware (ROM, RAM, EEPROM, I/0, processor, Power supply …).

2. Software

3. Real time Operating System (RTOS).

EXAMPLES


An Embedded System
Contact-less Smart Card Components
RAM (Temporary Variables)
ROM (Application and RTOS)
EEPROM (Application Variables)
Data, Address, Control Internal Buses
Account Number, Expiry Date, Card Number
Identifications Data Flow
Processor
Timer and Interrupt Controller
16 MHz Amplitude Shifted Key Modulator Circuit
Charge Pump Circuit
Interfacing I/O Circuit
System Power Supply
Transceiver Antenna on card

EXAMPLES

Telecom

- Mobile Computing
- Mobile Access

(a)

Smart Cards

- Banking
- Security

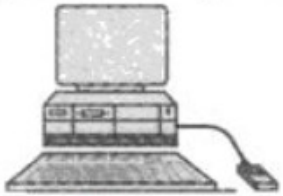
(b)

Missiles and Satellites

- Defence
- Aerospace
- Communication

(c)

Computer Networking Systems and Peripherals



- Networking Systems
- Image processing
- Printers
- Networks Cards
- Monitors and Displays

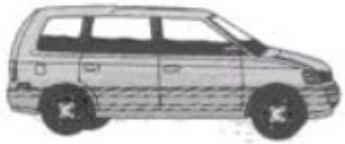
(d)

Digital Consumer Electronics

- DVDs
- Set top boxes
- High definition TVs
- Digital cameras

(e)

Automotive



- Motor Control System
- Cruise Control
- Engine/Body Safety
- Robotics in Assembly Line
- Car Entertainment
- Car Multimedia

(f)

Features of complicated Embedded Systems

1. Dedicated functions
2. Dedicated complex algorithms
3. GUI and user interface
4. Real time operations
5. Multi- rate operations: audio, video …

System Requirements

1. Memory

2. Processing speed

3. Low energy consumption

Design Requirements

1. Performance
2. Power
3. Size
4. Design cost
5. Packaging cost

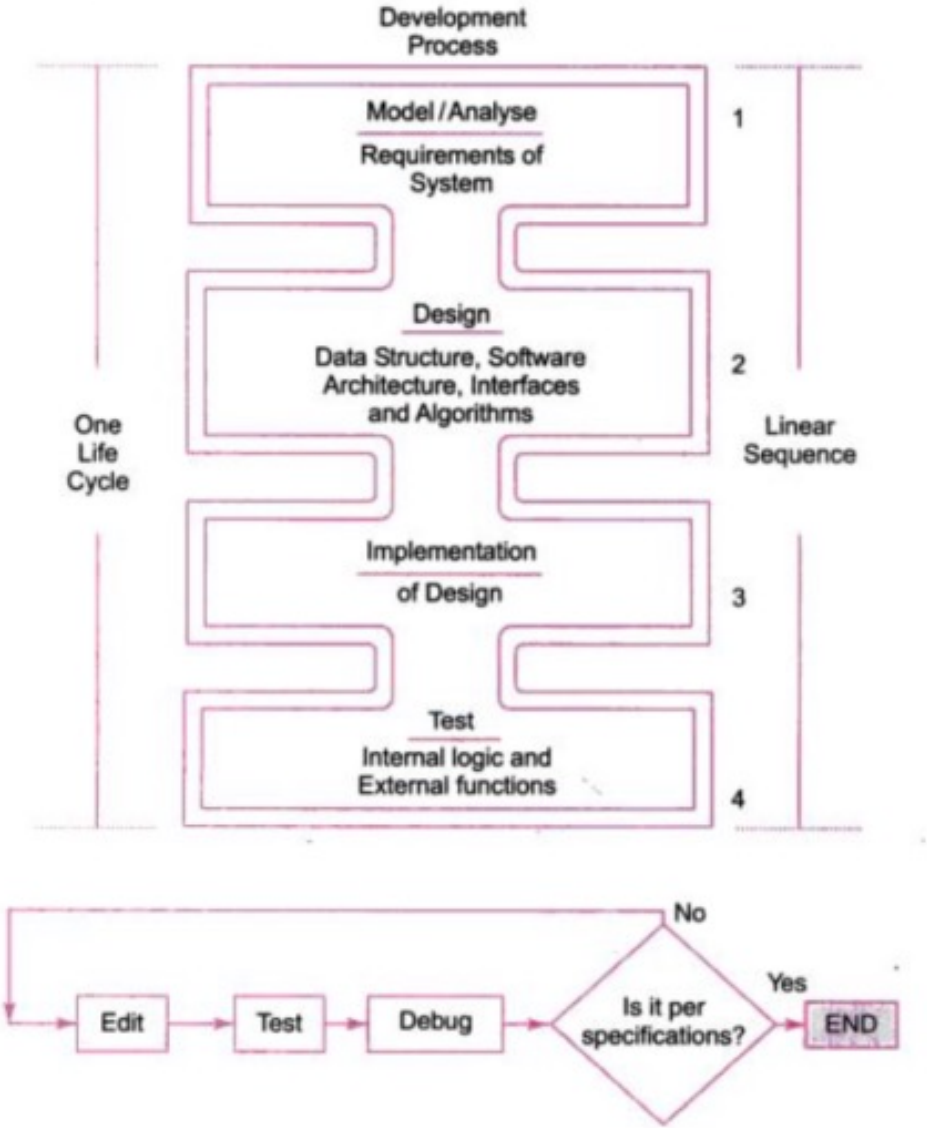
Design Process

1. Identify objectives/requirements of system
2. Identify the structure of hardware, software
3. The additional functions
4. Researching the similar design
5. Divide into modules (hardware, software)
6. Mapping
7. Design system interface
8. Update system

Design Requirements

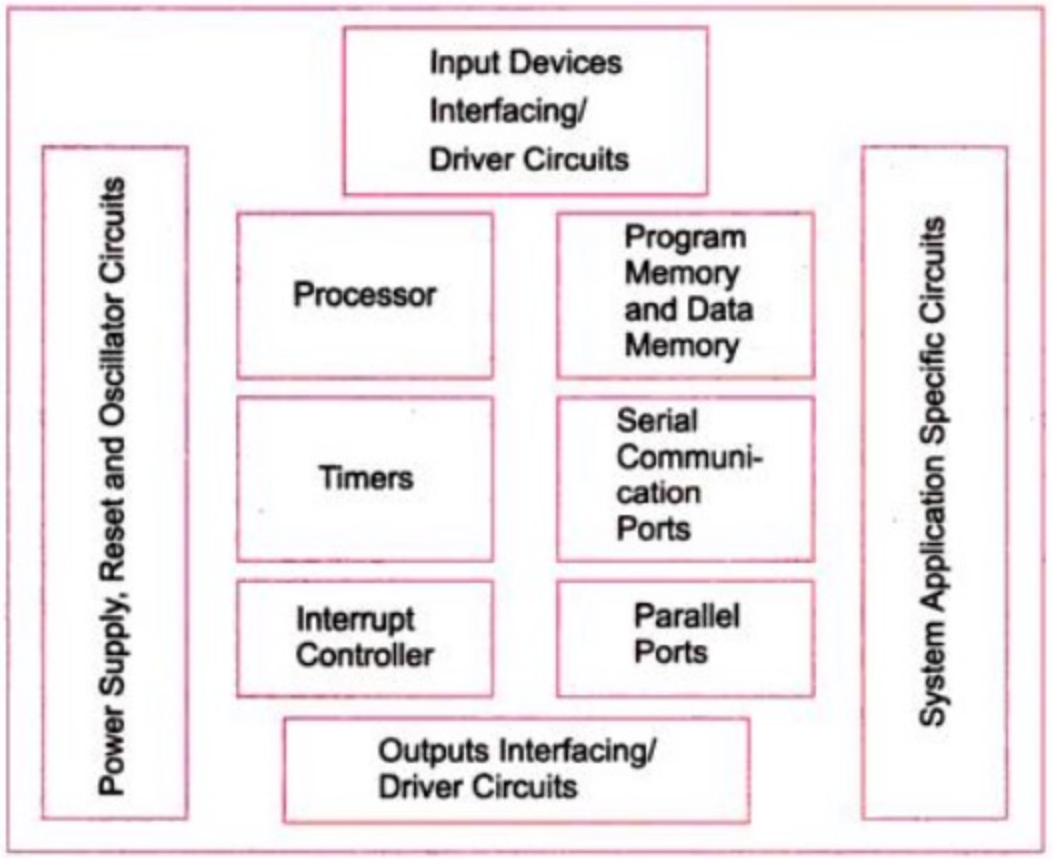
Design Metrics	*Description*
Power Dissipation	For many systems, particularly battery operated systems, such as mobile phone or digital camera the power consumed by the system is an important feature. The battery needs to be recharged less frequently if power dissipation is small.
Performance	Instructions execution time in the system measures the performance. Smaller execution time means higher performance. For example, a mobile phone, voice signals processed between antenna and speaker in 0.1s shows phone performance. Consider another. For example, a digital camera, shooting a 4M pixel still image in 0.5s shows the camera performance.
Process deadlines	There are number of processes in the system, for example, keypad input processing, graphic display refresh, audio signals processing and video signals processing. These have deadlines within which each of them may be required to finish computations and give results.
User interfaces	These include keypad GUIs and VUIs.
Size	Size of the system is measured in terms of (i) physical space required, (ii) RAM in kB and internal flash memory requirements in MB or GB for running the software and for data storage and (iii) number of million logic gates in the hardware.
Engineering cost	Initial cost of developing, debugging and testing the hardware and software is called engineering cost and is a one-time non-recurring cost.
Manufacturing cost	Cost of manufacturing each unit.
Flexibility	Flexibility in design enables, without any significant engineering cost, development of different versions of a product and advanced versions later on. For example, software enhancement by adding extra functions necessitated by changing environment and software re-engineering.
Prototype development time	Time taken in days or months for developing the prototype and in-house testing for system functionalities. It includes engineering time and making the prototype time.
Time-to-market	Time taken in days or months after prototype development to put a product for users and consumers.
System and user safety	System safety in terms of accidental fall from hand or table, theft (e.g., a phone locking ability and tracing ability) and in terms of user safety when using a product (for example, automobile brake or engine).
Maintenance	Maintenance means changeability and additions to the system; for example, adding or updating software, data and hardware. Example of software maintenance is additional service or functionality software. Example of data maintenance is additional ring-tones, wallpapers, video-clips in mobile phone or extending card expiry date in case of smart card. Example of hardware maintenance is additional memory or changing the memory stick in mobile computer and digital camera.

Design Process



Main parts of Embedded Systems

1. Processors
2. Basic circuit blocks
   - Power Source
   - Clock
   - Reset Circuit
   - Memory
   - IO ports
   - DAC/ADC
   - LED, LCD



Processor of Embedded Systems

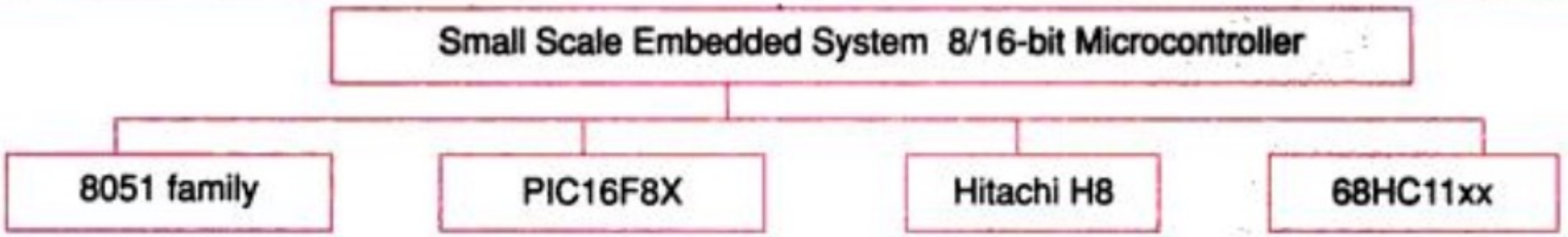
1. General purpose processor: Intel 80x86, Sparc, or Motorola 68HCxxx

2. ASIP (Application Specific Instruction-Set Processor): DSP, media, IO, network

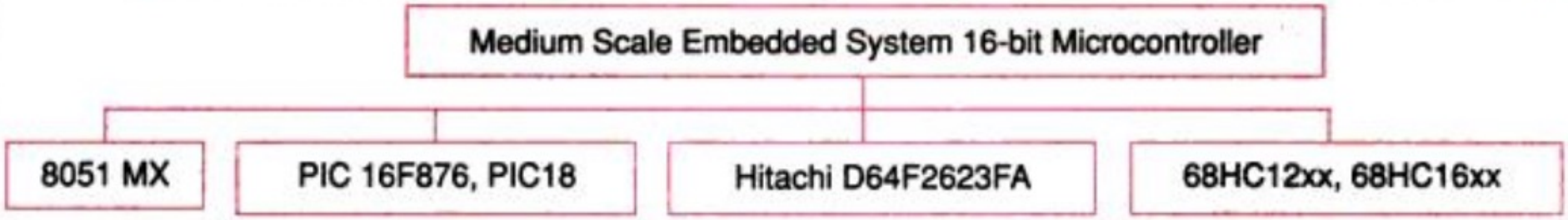
3. Single Purpose processor

4. Multiprocessor

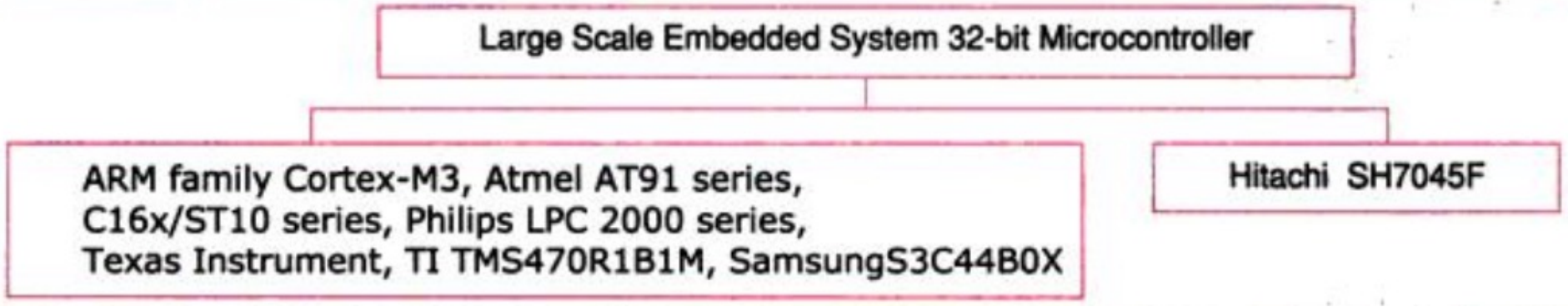
1. Small Scale Embedded System



2. Medium Scale Embedded Systems



3. Large Scale Embedded System



Single Purpose processor

- Floating point Coprocessor
- Pixel coprocessor
- Image codec in digital camera
- Graphic processor
- Speech processor
- Adaptive filtering processor
- Encryption engine
- Decryption engine
- Communication protocol stack processor

Multicore processors

- Multiprocessor system for Real time performance in a video-conference system.
- Embedded firewall cum router
- High-end cell phone

Software Requirements for Embedded Systems

- Application Programing: C++, Java.
- Device driver Programing: C, C++
- Android, web (basic) Programing.
- Script: Perl, Python, Shell script in Linux
- Good data structure and algorithms